TABLE 1 OF § 1065.202—DATA RECORDING AND CONTROL MINIMUM FREQUENCIES—Continued

Applicable test protocol section	Measured values	Minimum command and control frequency [a]	Minimum recording frequency [b c]
§ 1065.530; § 1065.545	Dilution air flow if actively controlled (for example, a partial-flow PM sampling system) [d].	5 Hz	1 Hz means.
§ 1065.530; § 1065.545	Sample flow from a CVS that has a heat exchanger.	1 Hz	1 Hz.
§ 1065.530; § 1065.545	Sample flow from a CVS that does not have a heat exchanger.	5 Hz	1 Hz means.

[a] The specifications for minimum command and control frequency do not apply for CFVs that are not using active control.
[b] 1 Hz means are data reported from the instrument at a higher frequency, but recorded as a series of 1 s mean values at a rate of 1 Hz.
[c] For CFVs in a CVS, the minimum recording frequency is 1 Hz. The minimum recording frequency does not apply for CFVs used to control sampling from a CVS utilizing CFVs.
[d] Dilution air flow specifications do not apply for CVS dilution air.

[79 FR 23759, Apr. 28, 2014]

§ 1065.205 Performance specifications for measurement instruments.

Your test system as a whole must meet all the calibrations, verifications, and test-validation criteria specified outside this section for laboratory testing or field testing, as applicable. We recommend that your instruments meet the specifications in Table 1 of this section for all ranges you use for testing. We also recommend that you keep any documentation you receive from instrument manufacturers showing that your instruments meet the specifications in Table 1 of this section.

TABLE 1 OF § 1065.205—RECOMMENDED PERFORMANCE SPECIFICATIONS FOR MEASUREMENT INSTRUMENTS

Measurement instrument	Measured quantity symbol	Complete system rise time (t_{10-90}) and fall time (t_{90-10}) [a]	Recording update frequency	Accuracy [b]	Repeatability [b]	Noise [b]
Engine speed transducer.	f_n	1 s	1 Hz means	2% of pt. or 0.5% of max.	1% of pt. or 0.25% of max.	0.05% of max.
Engine torque transducer.	T	1 s	1 Hz means	2% of pt. or 1% of max.	1% of pt. or 0.5% of max.	0.05% of max.
Electrical work (active-power meter).	W	1 s	1 Hz means	2% of pt. or 0.5% of max.	1% of pt. or 0.25% of max.	0.05% of max.
General pressure transducer (not a part of another instrument).	p	5 s	1 Hz	2% of pt. or 1% of max.	1% of pt. or 0.5% of max.	0.1% of max.
Atmospheric pressure meter for PM-stabilization and balance environments.	p_{atmos}	50 s	5 times per hour.	50 Pa	25 Pa	5 Pa
General purpose atmospheric pressure meter.	p_{atmos}	50 s	5 times per hour.	250 Pa	100Pa	50 Pa
Temperature sensor for PM-stabilization and balance environments.	T	50 s	0.1 Hz	0.25 K	0.1 K	0.1 K
Other temperature sensor (not a part of another instrument).	T	10 s	0.5 Hz	0.4% of pt. K or 0.2% of max K.	0.2% of pt. K or 0.1% of max K.	0.1% of max.
Dewpoint sensor for intake air, PM-stabilization and balance environments.	T_{dew}	50 s	0.1 Hz	0.25 K	0.1 K	0.02 K

TABLE 1 OF § 1065.205—RECOMMENDED PERFORMANCE SPECIFICATIONS FOR MEASUREMENT INSTRUMENTS—Continued

Measurement instrument	Measured quantity symbol	Complete system rise time (t_{10-90}) and fall time (t_{90-10}) [a]	Recording update frequency	Accuracy [b]	Repeatability [b]	Noise [b]
Other dewpoint sensor.	T_{dew}	50 s	0.1 Hz	1 K	0.5 K	0.1 K
Fuel flow meter [c] (Fuel totalizer).	$\dot{m}$	5 s (—)	1 Hz (—)	2% of pt. or 1.5% of max.	1% of pt. or 0.75% of max.	0.5% of max.
Total diluted exhaust meter (CVS) [c] (With heat exchanger before meter).	$\dot{n}$	1 s (5 s)	1 Hz means (1 Hz)	2% of pt. or 1.5% of max.	1% of pt. or 0.75% of max.	1% of max.
Dilution air, inlet air, exhaust, and sample flow meters [c].	$\dot{n}$	1 s	1 Hz means of 5 Hz samples.	2.5% of pt. or 1.5% of max.	1.25% of pt. or 0.75% of max.	1% of max.
Continuous gas analyzer.	x	5 s	1 Hz	2% of pt. or 2% of meas.	1% of pt. or 1% of meas.	1% of max.
Batch gas analyzer ..	x			2% of pt. or 2% of meas.	1% of pt. or 1% of meas.	1% of max.
Gravimetric PM balance.	m_{PM}			See § 1065.790	0.5 μg	
Inertial PM balance	m_{PM}	5 s	1 Hz	2% of pt. or 2% of meas.	1% of pt. or 1% of meas.	0.2% of max

[a] The performance specifications identified in the table apply separately for rise time and fall time.
[b] Accuracy, repeatability, and noise are all determined with the same collected data, as described in § 1065.305, and based on absolute values. "pt." refers to the overall flow-weighted mean value expected at the standard; "max" refers to the peak value expected at the standard over any test interval, not the maximum of the instrument's range; "meas" refers to the actual flow-weighted mean measured over any test interval.
[c] The procedure for accuracy, repeatability and noise measurement described in § 1065.305 may be modified for flow meters to allow noise to be measured at the lowest calibrated value instead of zero flow rate.

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MEASUREMENT OF ENGINE PARAMETERS AND AMBIENT CONDITIONS

§ 1065.210 Work input and output sensors.

(a) *Application.* Use instruments as specified in this section to measure work inputs and outputs during engine operation. We recommend that you use sensors, transducers, and meters that meet the specifications in Table 1 of § 1065.205. Note that your overall systems for measuring work inputs and outputs must meet the linearity verifications in § 1065.307. We recommend that you measure work inputs and outputs where they cross the system boundary as shown in Figure 1 of § 1065.210. The system boundary is different for air-cooled engines than for liquid-cooled engines. If you choose to measure work before or after a work conversion, relative to the system boundary, use good engineering judgment to estimate any work-conversion losses in a way that avoids overestimation of total work. For example, if it is impractical to instrument the shaft of an exhaust turbine generating electrical work, you may decide to measure its converted electrical work. As another example, you may decide to measure the tractive (i.e., electrical output) power of a locomotive, rather than the brake power of the locomotive engine. In these cases, divide the electrical work by accurate values of electrical generator efficiency ($\eta<1$), or assume an efficiency of 1 ($\eta=1$), which would over-estimate brake-specific emissions. For the example of using locomotive tractive power with a generator efficiency of 1 ($\eta=1$), this means using the tractive power as the brake power in emission calculations. Do not underestimate any work conversion efficiencies for any components outside the system boundary that do not return work into the system boundary. And do not overestimate any work conversion efficiencies for components outside the system boundary that do return work into the system boundary. In all cases, ensure that you are able to accurately demonstrate compliance with the applicable standards.